SCHOOL OF CIVIL ENGINEERING

JOINT HIGHWAY RESEARCH PROJECT

JHRP-76-33

LANDSCAPE PLANT RESPONSE TO DIFFERENT LEVELS OF FOUR "SLOW RELEASE" FERTILIZERS

P.L. Carpenter
David F. Hamilton
Robert E. McNiel
N. Levinskas

PURDUE UNIVERSITY
INDIANA STATE HIGHWAY COMMISSION

Interim Report

LANDSCAPE PLANT RESPONSE TO DIFFERENT LEVELS OF FOUR "SLOW RELEASE" FERTILIZERS

TO: J. F. McLaughlin, Director
Joint Highway Research Project

December 1, 1976
Revised November 1977
Project: C-36-48G

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

File: 9-5-7

The attached Interim Report is on the HPR Part II Study titled "Development of Techniques for Plant Establishment on the Roadside". It is titled "Landscape Plant Response to Different Levels of Four "Slow Release" Fertilizers", and has been authored by four researchers who worked on this phase from the Department of Horticulture under the direction of Professor Philip L. Carpenter, the principal investigator.

The Report emphasizes that adding of fertilizer to new plantings must be done with care and often is not beneficial and it recommends that "slow release" fertilizers not be used for new plantings.

The Report is submitted in partial fulfillment of the objectives of this Study. After acceptance by the JHRP Board it will be submitted to ISHC and FHWA for review and similar acceptance. Final preparation of the report copy will then follow.

Respectfully submitted,

Harold L. Michael

Harold L. Michael
Associate Director

HLM:ms

cc: W. L. Dolch
R. L. Eskew
G. D. Gibson
W. H. Goetz
M. J. Gutzwiller
G. K. Hallock
D. E. Hancher
M. L. Hayes
K. R. Hoover
G. A. Leonards
R. D. Miles
P. L. Owens
G. T. Satterly
C. F. Scholer
M. B. Scott
K. C. Sinha
L. E. Wood
E. J. Yoder
S. R. Yoder

Digitized by the Internet Archive
in 2011 with funding from
LYRASIS members and Sloan Foundation; Indiana Department of Transportation

http://www.archive.org/details/landscapeplantre00carp

Interim Report

LANDSCAPE PLANT RESPONSE TO DIFFERENT LEVELS OF FOUR "SLOW RELEASE" FERTILIZERS

by

Philip L. Carpenter

David F. Hamilton

Robert E. McNiel

Nancy Levinskas

Department of Horticulture
Purdue University

Joint Highway Research Project

Project No.: C-36-48G

File No.: 9-5-7

Prepared as Part of an Investigation

Conducted by

Joint Highway Research Project
Engineering Experiment Station
Purdue University

in cooperation with the

Indiana State Highway Commission

and the

U.S. Department of Transportation
Federal Highway Administration

The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the Federal Highway Administration.

Purdue University
West Lafayette, Indiana
December 1, 1976
Revised November 1977

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.
JHRP-76-33

2. Government Accession No.

3. Recipient's Catalog No.

4. Title and Subtitle
LANDSCAPE PLANT RESPONSE TO DIFFERENT LEVELS
OF FOUR 'SLOW RELEASE' FERTILIZERS

5. Report Date Dec. 1, 1976
Revised Nov. 1977

6. Performing Organization Code
C-36-48G

7. Author(s) P. L. Carpenter, D. F. Hamilton, R. E. McNiel, and Nancy Levinskas

8. Performing Organization Report No.
JHRP-76-33

9. Performing Organization Name and Address
Joint Highway Research Project
Civil Engineering Building
Purdue University
West Lafayette, Indiana 47907

10. Work Unit No.

11. Contract or Grant No.
HPR-1(14) Part II

12. Sponsoring Agency Name and Address
Indiana State Highway Commission
State Office Building
100 North Senate Avenue
Indianapolis, Indiana 46204

13. Type of Report and Period Covered
Interim Report
"Slow Release"
Fertilizers

14. Sponsoring Agency Code
CA 387

15. Supplementary Notes
Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration. Research Study titled "Development of Techniques for Plant Establishment on the Roadside".

16. Abstract

Four "slow release" fertilizers were evaluated as to their effect on the establishment and subsequent growth of plants along roadsides. The materials were added to backfill soil at planting. Plant survival appeared to be more important than annual increases in growth. High levels of fertilizer reduced the survival of all species. Viburnum dentatum was affected even at lower rates. The survival of Fraxinus pennsylvanica and Lonicera morrowii was good, except at high fertilizer levels. Excess rainfall shortly after planting may have increased the concentration of dissolved fertilizer salts to toxic levels around the new roots. Those plants not killed immediately may have been weakened to the point where resistance to environmental stress was reduced.

Further work is indicated in the selection of species that will tolerate the inherent low nutrient levels and stresses associated with highway sites or that will withstand and respond favorably to fertilizers applied at planting.

17. Key Words
Roadside Plantings, Landscape Plantings, Slow Release Fertilizers, Fertilizers

18. Distribution Statement
No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)
Unclassified

20. Security Classif. (of this page)
Unclassified

21. No. of Pages
18

22. Price

Form DOT F 1700.7 (8-69)

Highlight Summary

Roadside soils are generally unavoidably disturbed during the construction phase. The result is that these soils are quite low in plant nutrients, especially nitrogen. Nitrogen is critical for the growth and development of plants, but, the establishment of permanent optimum levels in the soil is impossible. Four "slow release" fertilizers (IBDU, Mag Amp, Tree Food Spike and Agriform Tablet) were evaluated as to their effect on the establishment and subsequent growth of woody plants an roadsides, and as possibly economic alternatives to costly periodic applications of nitrogen fertilizer. The materials were added to the hole at planting time.

Plant survival appeared to be more affected by the treatments than did yearly increases in growth. All of the plant species failed to survive at various high levels of fertilizers. *Viburnum dentatum* and *Acer sp* appeared to be the most sensitive even at lower levels and *Fraxinus pennsylvanica* and *Lonicera morrowi* appeared to be more tolerant, except at higher levels. Excessive rainfall shortly after planting could have increased the levels of dissolved fertilizer salts in the root zone to toxic or debilitating levels.

Further work in selection of plants that will endure the inherent stresses of roadside soils or that will tolerate and benefit from fertilizer application at planting time is indicated.

Table of Contents

Introduction 1

Materials and Methods 2

Results and Discussion 5

Conclusion 18

List of Tables

Table	Page
1. Fertilizer Treatments Established at Time of Planting	3
2. Survival of _Acer rubrum_ as Affected by Fertilizer Treatment	7
3. Survival of _Fraxinus pennsylvanica_ as Affected by Fertilizer Treatment	8
4. Survival of _Viburnum dentatum_ as Affected by Fertilizer Treatment	9
5. Survival of _Lonicera morrowii_ as Affected by Fertilizer Treatment	10
6. Average Plant heights at the End of 1976	13

List of Figures

Figure	Page
1. Percent plant survival in 1976 as affected by fertilizer treatments	11
2. Weekly rainfall totals from May - September 1973	14
3. Growth response of landscape plants as affected by fertilizer treatment	15
4. Weekly rainfall totals from May - September 1974	16
5. Weekly rainfall totals from May - September 1975	17

Landscape plant Response to Different Levels of Four "Slow Release" Fertilizers

Introduction:

The soils along many highways have been unavoidably disturbed during the construction phase of the highway and the result is that the soils available for plant growth after construction are often very poor in structure and have very low fertility levels. The establishment and subsequent growth of landscape plants is controlled to a large extent by the soil conditions at the site. The low fertility levels can largely be corrected at the time the landscape plants are planted except for nitrogen. Nitrogen is not held tightly by the soil and is constantly being leached from the soil and/or being utilized by soil micro-organisms. It is generally considered impossible to provide long term sources of nitrogen from fertilizers for plant growth at the time of planting landscape plants. Periods of longer than one year are considered long term.

At the same time that establishing permament optimum levels of nitrogen in the soil is impossible, the nutrient element that most investigators regard as critical for the growth and development of woody landscape plants is nitrogen. The personnel concerned with highway maintenance face a dilemma in trying to provide an adequate nitrogen supply over long periods of time on essentially nitrogen depleted soils. The costs of fertilizers are high, and maintenance budgets are under constant pressure to be reduced. Also, the expenditure of large amounts of fertilizers on the roadside may not be accepted by the public with the current emphssis on fertilizer and energy shortages. Therefore, the use of "slow release" nitrogen fertilizers at planting time of landscape plants might be of

great benefit to the future growth and development of the landscape plant.

Initial experiments were conducted on a site near the Purdue campus and the results were reported in Interim Report # June 1972 - November 10 and Final report July 1972 - November 23. The results obtained were contrary to current thinking; i.e. the loss of certain landscape plants when fertilizer levels were high, even though levels were not in excess of manufacturers recommendations. Therefore, the following experiment was designed to verify these results and also study the usefulness of "slow release" fertilizers on actual roadside conditions.

Materials and Methods:

A site at the I-65 - Indiana 43 interchange was selected to determine the effectiveness of 4 different fertilizer materials that might have "slow release" nitrogen properties. All fertilizers are available commercially. The soil at the site was principally subsoil and parent material with a pH of 7.2. Internal drainage was thought to be relatively poor. (This determination was made by physical examination. No purcolation studies were run.)

Planting holes at the site were dug with a tractor mounted 20" (50cm) auger to an approximate depth of 24" (60cm). The volume of soil removed from the hole was calculated to be 4.4 cu ft (.12 cu m). The soil removed from the hole was used as the backfill material. No peat moss or sand additives were mixed with the backfill material.

Five plant species were selected for this study - three deciduous trees and two deciduous shrubs. The trees were _Acer saccharum_, _A. rubrum_, and _Fraximus pennsylvania_ and the shrubs were _Viburnum dentatum_ and _Lonicera morrowii_. The trees were purchased from a commercial nursery as bare

Table 1.

Fertilizer Treatments Established at Time of Planting

Treatments	Quantity/Hole (grams)	N/Hole (grams)	Analysis (%N; P_2O_5; K_2O)
Check	0	0	
Agriform Tablet	42 (2 Tablets)	8.4	20-10-5
Abriform Tablet	84 (4 Tablets)	16.8	
Mag Amp	113	8.0	7-40-6
Mag Amp	227	15.9	
Mag Amp	445	32.0	
IBDU[y]	28	8.8	32-0-0
IBDU[y]	56	17.6	
Tree Food Spike	150 (1 Spike)	32.0	16-8-8
Tree Food Spike	300 (2 Spike)	64.0	

[y] Supplemented with 6.5 g 0-46-0 and 2.5 g 0-0-60 per hole.

root seedlings with a size range of 24" - 36". The shrubs were more fully developed bare root plants of 24" - 36". The plants were left in the original packing material until planted at the site. After planting both trees and the viburnum were cut back to a uniform height.

Four different fertilizer materials were used at various concentrations to establish the 10 different treatments. Table 1 presents these treatments. The Agriform tablet is a urea-formaldehyde material that will supply nitrogen over a longer period than many fertilizer materials due to the size of the tablet and the low water solubility of the urea-formaldehyde complex. Mag Amp is a magnesium ammonium phosphorus complex with a low water solubility that releases nitrogen as it is slowly dissolved by water. Both the Agriform tablets and the Mag Amp are complete fertilizer containing phosphorus and potassium as well as nitrogen. IBDU is a urea complex that has low solubility properties, and by varying the particle size the rate of nitrogen release can be varied. However, IBDU does not contain phosphorus of potassium. The Tree Food Spike is not designed for use at planting time, but it was felt that it might have a potential use on highway planting sites. It is designed for fertilizing large, established trees. The spike weighs approximately 150 grams and consists of an agricultural grade fertilizer with an analysis of 16-8-8 that is held together with a urea-formaldehyde resin. Its size plus the resin binder gives the spike slow release properties.

The fertilizer treatments were applied as each plant was planted. See Table 1 for the rates used. When the planting hole was ½ full the Agriform Tablets and the Tree Food Spikes were placed in the planting hole near the outside edge of the hole equal distance from each other.

Six inches (15 cm) of backfill soil was added to the hole and the Mag Amp and the IBDU treatments were added to the bottom of the hole. The fertilizers were mixed into the soil after it was added to the bottom of the hole. Supplemental additives of phosphorous and potassium were added to the IBDU treatments (See Table 1).

After the planting operation was completed, each plant was watered with approximately 2 gallons (8 liters) of water. The initial watering was completed by 25 April 1973 and a second watering was done eight weeks later. Due to large rainfalls during the second week in July and the first week in August no additional waterings were made. Highway planting specifications call for two additional waterings after the initial one at planting time.

Each treatment was replicated four times with each replication of the treatment containing 3 plants of each species except with the maples, where 1 plant was a sugar maple and 2 plants were red maples.

Weeds and grass were mown twice per year by the regular highway mowing crews. Growth of the maples was so poor that many were mown off during 1975. Little or no growth has occurred since planting and it was nearly impossible to see many of the trees when mowing.

The following data were collected after the experiment was set up:

1. Percent survival each year after planting.
2. Average growth of surviving plants.
3. Weekly rainfall for 1973, 1974, and 1975.

Results and Discussion:

Plant survival appears to be more important in this experiment than growth each year after planting. There was a definite effect of treatment

on survival. Sugar maple seedling survival was very poor in all treatments. The quality of *Acer saccharum* seedling was so poor that treatment was not the reason for their poor survival. The medium and high levels of Mag Amp reduced the stand of red maple (*Acer rubrum*) as well as the one Tree Food Spike treatment. But overall poor growing conditions at the site prevented the trees from growing properly and it is impossible to say for certain that the fertilizer treatments killed the plants. See Table 2.

In the case of the green ash (*Fraximus pennsylvanica*) survival was excellent regardless of the treatment except with the high level of Mag Amp and the 300 g of Tree Food Spikes. The stand was reduced to nearly 50% at the end of 4 growing seasons in their two treatments. Overall survival of green ash was quite good. (See Table 3.)

The survival of the viburnums (*Viburnum dentatum*) was greatly affected by some of the fertilizer treatments. The high rate of all fertilizer treatments caused some reduction in survival. However, the medium and high levels of Mag Amp and high level of Tree Food Spike caused the greatest reduction in survival. IBDU and Agriform treatments had the least affect. *Viburnum dentatum* appears to be very sensative to fertilizers and injury occurs even at lower rates. If no fertilizer is used this viburnum will survive without difficulty providing other factors, such as lack of moisture, are not limiting. (See Table 4.)

Honeysuckle (*Lonicera Morrowii*) was only affected by the high level of the Tree Food Spike (300 g). This plant should be a stronger plant for landscape purposes on areas of adverse soil conditions than the viburnum studied in this project. (See Table 5.) Figure 1 shows the comparison of the survival of green ash, viburnum, and Morrow honeysuckle in 1976. It can be seen that the poorest survival was with the viburnum.

Table 2

Survival of *Acer rubrum* as Affected by Fertilizer Treatment

Treatment	Rate/gram	% Survival 1973	1974	1975
Check	0	50	33	25
Agriform Tablet	42	50	42	33
Agriform Tablet	84	83	50	25
Mag Amp	113	33	17	17
Mag Amp	227	0	0	0
Mag Amp	455	8	0	0
IBDU	28	33	33	25
IBDU	56	42	42	0
Tree Food Spike	150	17	0	0
Tree Food Spike	300	67	33	25

Table 3

Survival of *Fraxinus pennsylvanica* as Affected by Fertilizer Treatment

Treatment	Rate/gram	% Survival 1973	1974	1975	1976
Check	0	100	100	100	100
Agriform Tablet	42	100	100	100	92
Agriform Tablet	84	100	100	100	100
Mag Amp	113	92	92	92	92
Mag Amp	227	100	100	100	92
Mag Amp	455	92	75	67	58
IBDU	28	100	100	100	100
IBDU	56	100	100	100	83
Tree Food Spike	150	92	92	92	92
Tree Food Spike	300	75	67	67	58

Table 4

Survival of *Viburnum dentatum* as Affected by Fertilizer Treatment

Treatment	Rate/gram	% Survival 1973	1974	1975	1976
Check	0	100	100	100	100
Agriform Tablet	42	92	92	92	92
Agriform Tablet	84	75	67	58	58
Mag Amp	113	67	67	67	67
Mag Amp	227	58	58	50	42
Mag Amp	455	33	25	8	8
IBDU	28	100	100	92	83
IBDU	56	83	83	67	67
Tree Food Spike	150	83	83	67	67
Tree Food Spike	300	33	8	8	8

Table 5

Survival of *Lonicera morrowii* as Affected by Fertilizer Treatment

Treatment	Rate/gram	% Survival 1973	1974	1975	1976
Check	0	92	92	92	92
Agriform Tablet	42	100	100	100	100
Agriform Tablet	84	92	92	92	92
Mag Amp	113	100	100	100	100
Mag Amp	227	83	83	83	75
Mag Amp	455	83	83	83	83
IBDU	28	100	100	100	100
IBDU	56	92	92	92	92
Tree Food Spike	150	92	92	92	92
Tree Food Spike	300	58	58	58	58

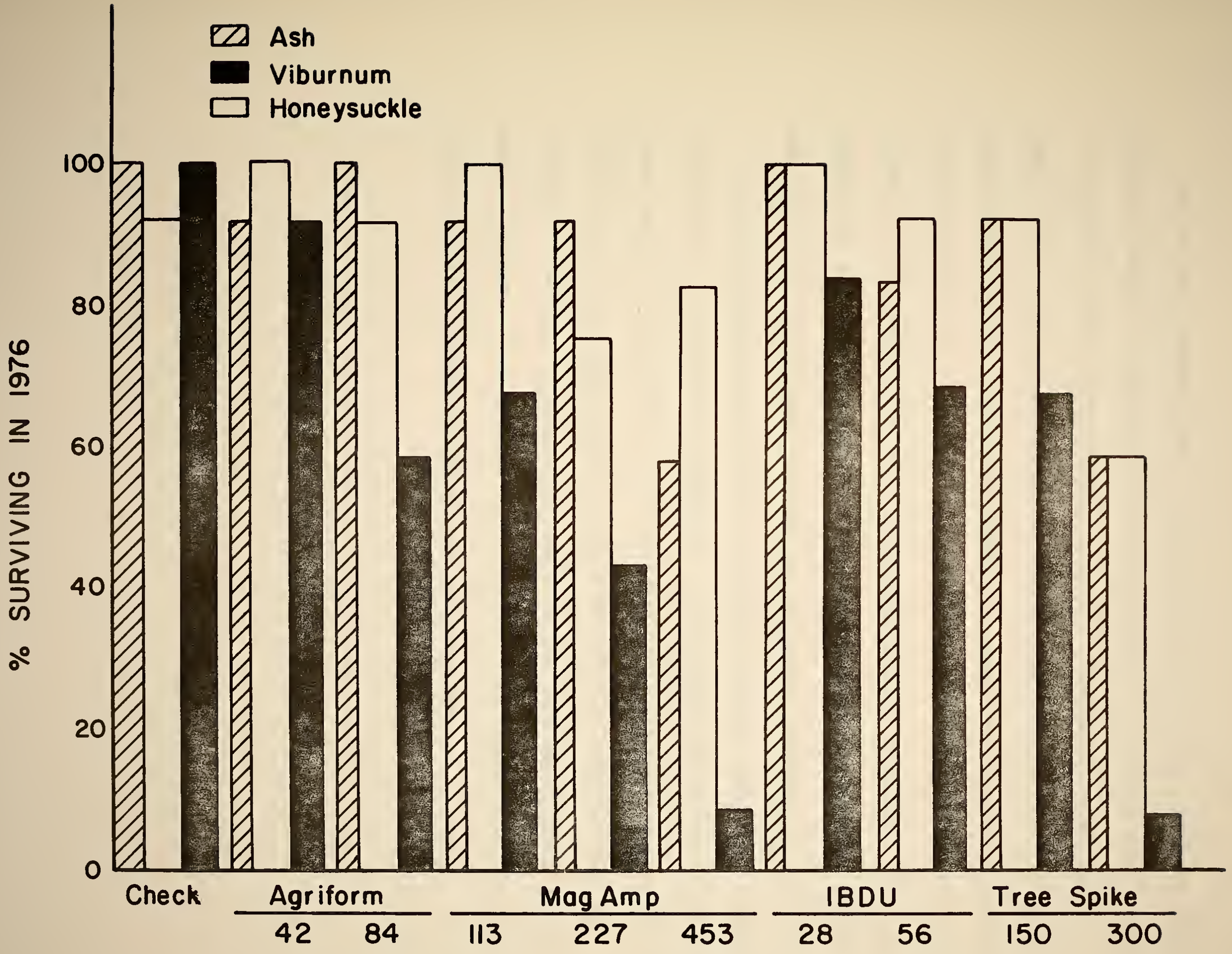

Figure 1. Percent plant survival in 1976 as affected by fertilizer treatments.

One of the reasons that a large plant loss occurred with the high fertility level treatments was the high amount of rainfall that occurred in June 1973 after planting (See Figure 2). The water remained in planting holes for a long enough period of time that much of the fertilizer was dissolved. The concentration of dissolved fertilizer salts in the water in the planting hole could have reached sufficiently high levels to have killed the roots of the newly planted tree or shrub. It is believed that the plants could also have been weakened to a point where some plant loss could have occurred in the years following planting.

Growth response was very poor regardless of the treatment. Figure 3 and Table 6 give the data obtained. It is apparent that no significant growth occurred regardless of the treatment. It has been suggested in other plant establishment work in other states that moisture may be limiting. However, rainfall data taken do not show any periods of excessive drought. (See Figures 2, 4, and 5). The reason for the poor growth cannot be accounted for at the present time.

Table 6

Average Plant Heights at the End of 1976

Treatment	Rate/gram	Ash	Viburnum	Honeysuckle
Check	0	22.8 (12)	29.3 (12)	22.3 (11)
Agriform Tablet	42	25.6 (11)	29.1 (11)	23.4 (12)
Agriform Tablet	84	27.8 (12)	25.9 (7)	27.6 (11)
Mag Amp	113	31.6 (11)	26.1 (8)	21.5 (12)
Mag Amp	227	26.1 (11)	22.0 (5)	22.9 (9)
Mag Amp	455	27.7 (7)	28.0 (1)	24.0 (10)
IBDU	28	31.1 (12)	27.7 (11)	21.2 (12)
IBDU	56	29.9 (10)	27.0 (8)	22.2 (11)
Tree Food Spike	150	30.9 (11)	26.6 (8)	22.1 (11)
Tree Food Spike	300	36.0 (7)	27.0 (1)	22.3 (7)

The calculations include only those plants alive in 1976; this number appears in parentheses after each mean. It is assumed that the initial plant heights were 24" for ash and viburnum, and 30" for honeysuckle, so 6" was subtracted from each honeysuckle mean so that it can be directly compared with the ash and viburnum means.

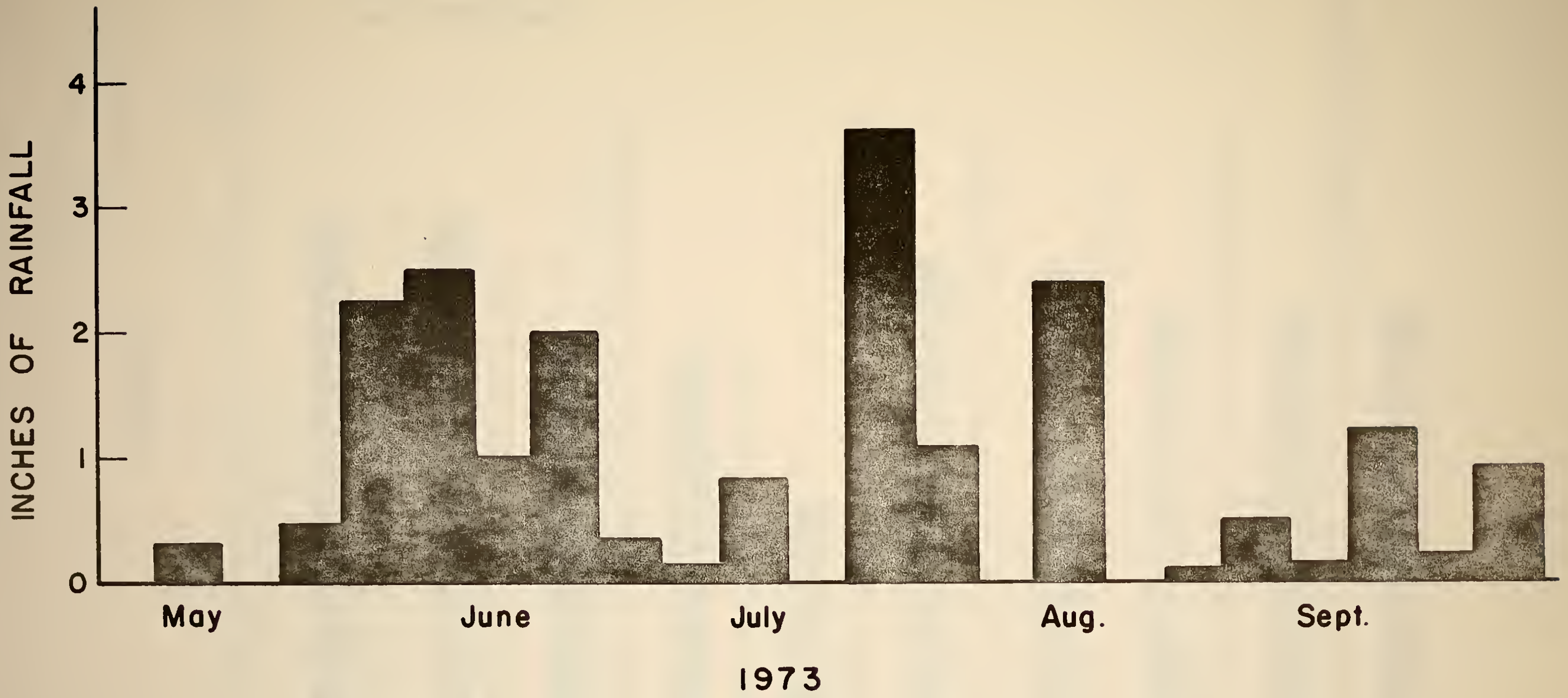

Figure 2. Weekly rainfall totals from May - September 1973.

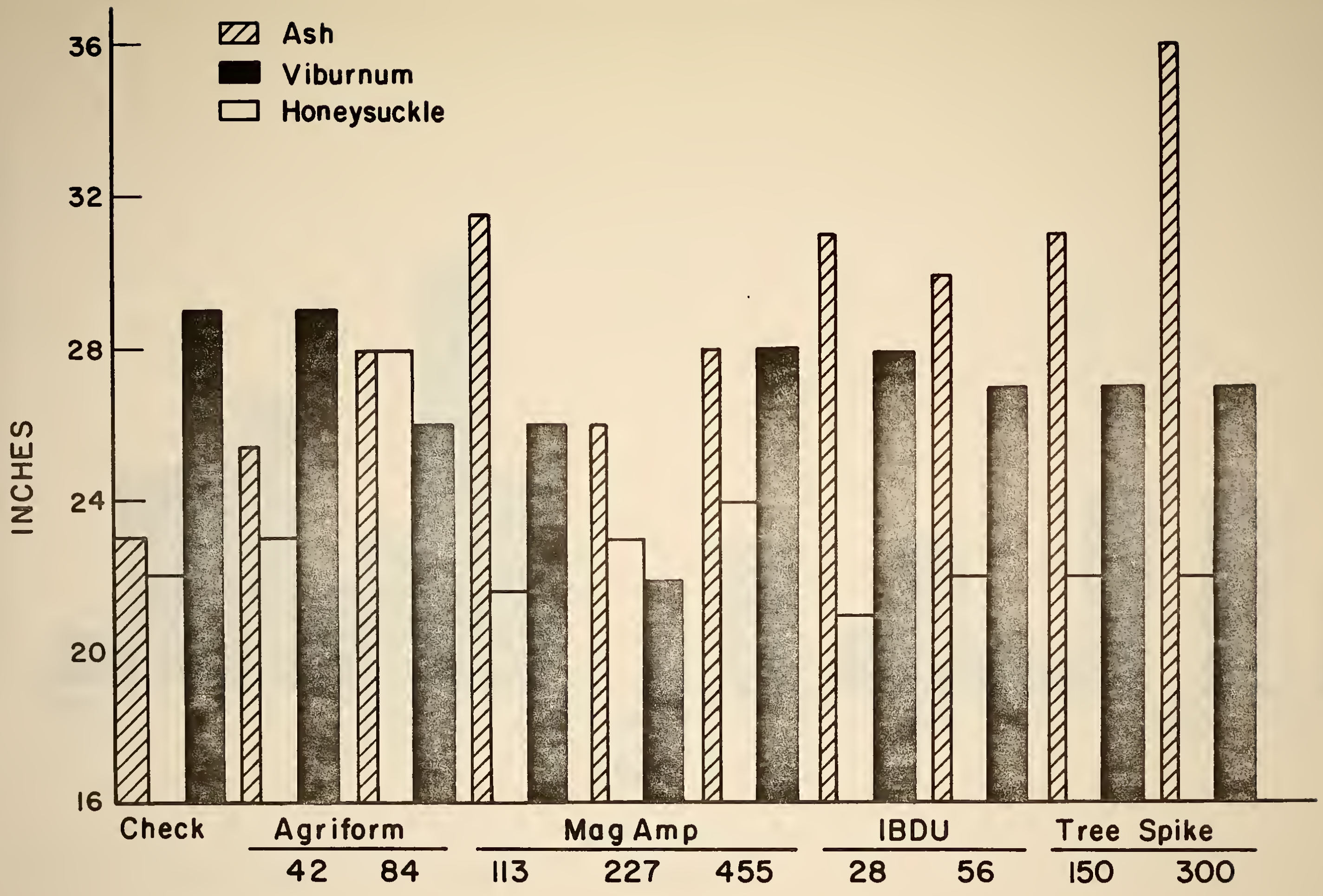

Figure 3. Growth response of landscape plants as affected by fertilizer treatment.

[illegible]

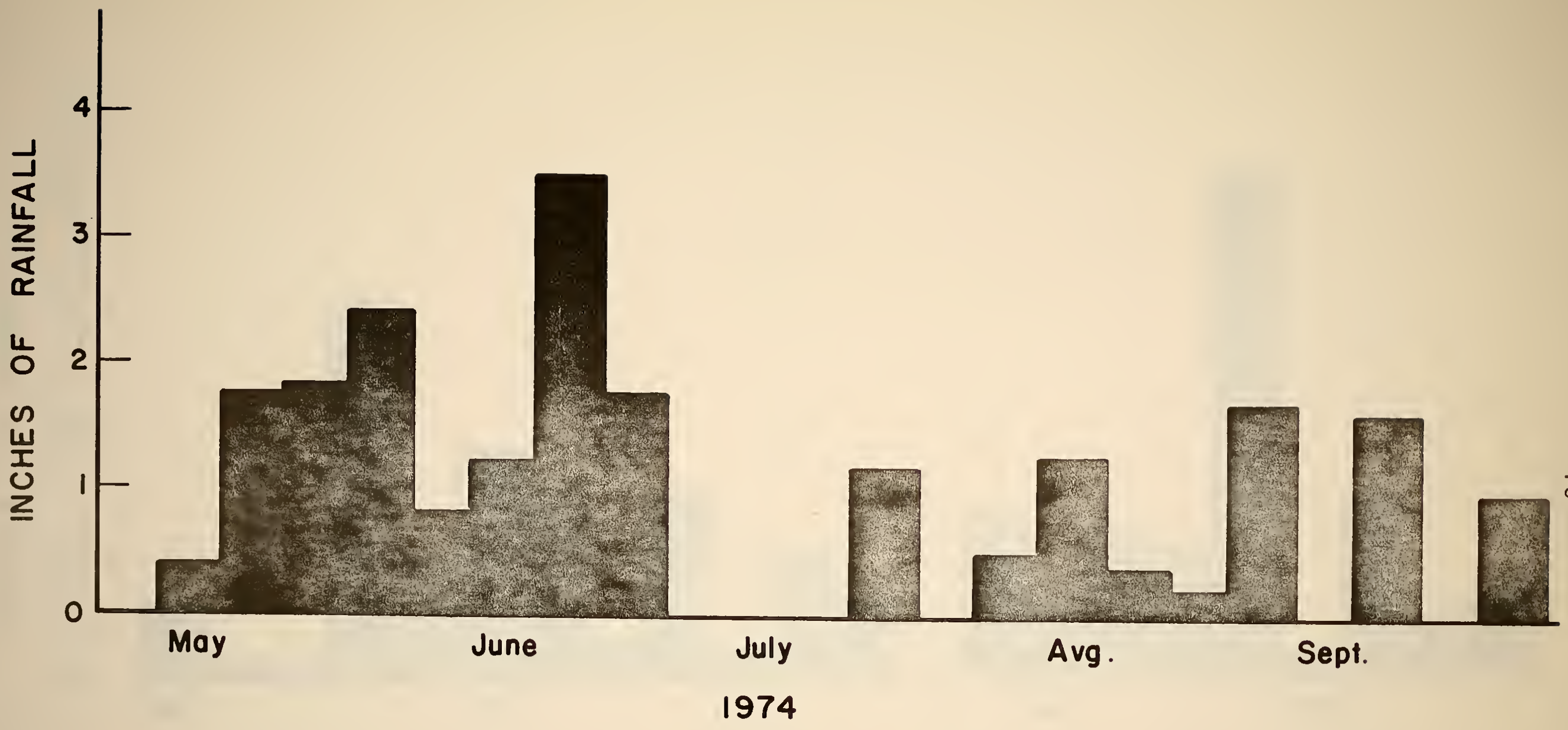

Figure 4. Weekly rainfall totals from May - September 1974.

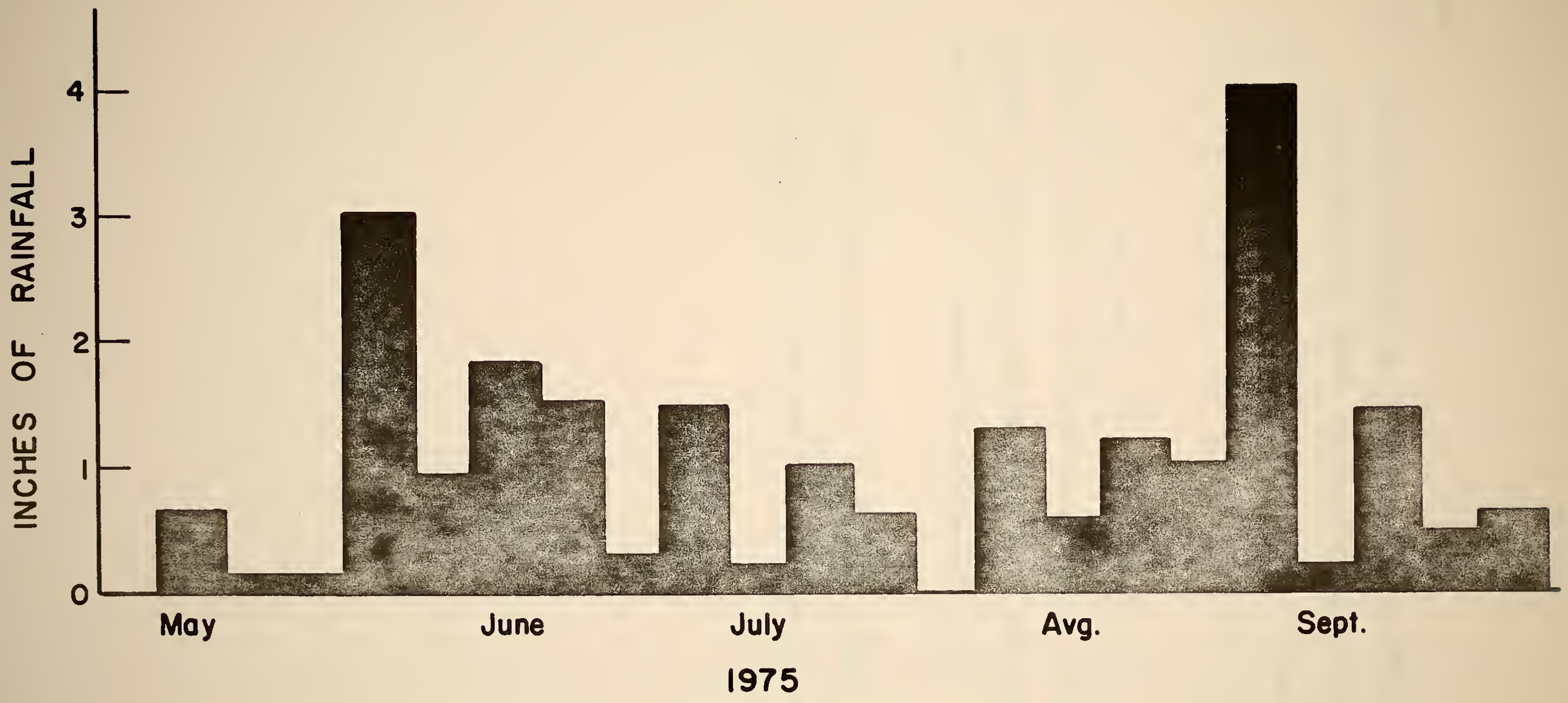

Figure 5. Weekly rainfall totals from May - September 1975.

Conclusion:

The following conclusions can be drawn from this experiment:

1. Landscape plant growth on highly disturbed soils of certain roadside sites is not limited by lack of nitrogen as much as by other environmental factors such as moisture stress.

2. Certain plant species will not tolerate even moderate fertilizer additions in the backfill mixtures. Of the 4 species studied, maple and viburnum appear to be most sensitive. Green ash and Morrow's honeysuckle survive quite well.

3. At the present time the use of "slow release" fertizlier for new plantings on the roadside cannot be recommended.

COVER DESIGN BY ALDO GIORGINI